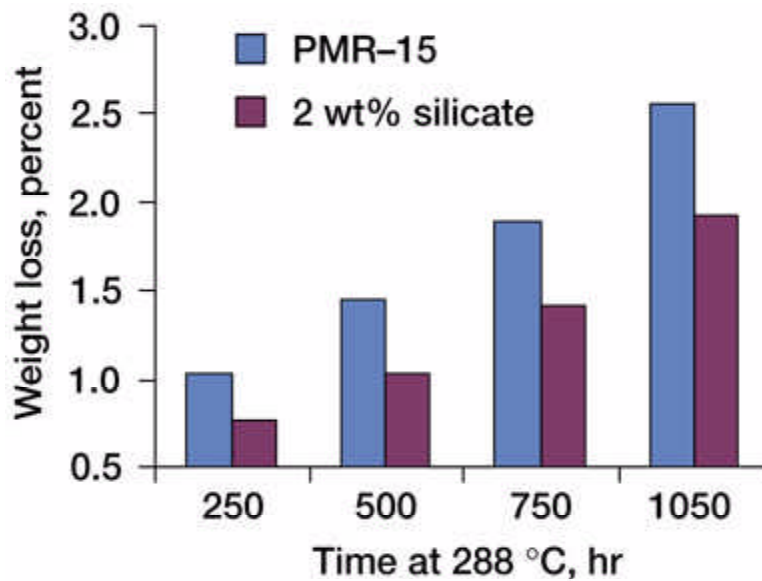


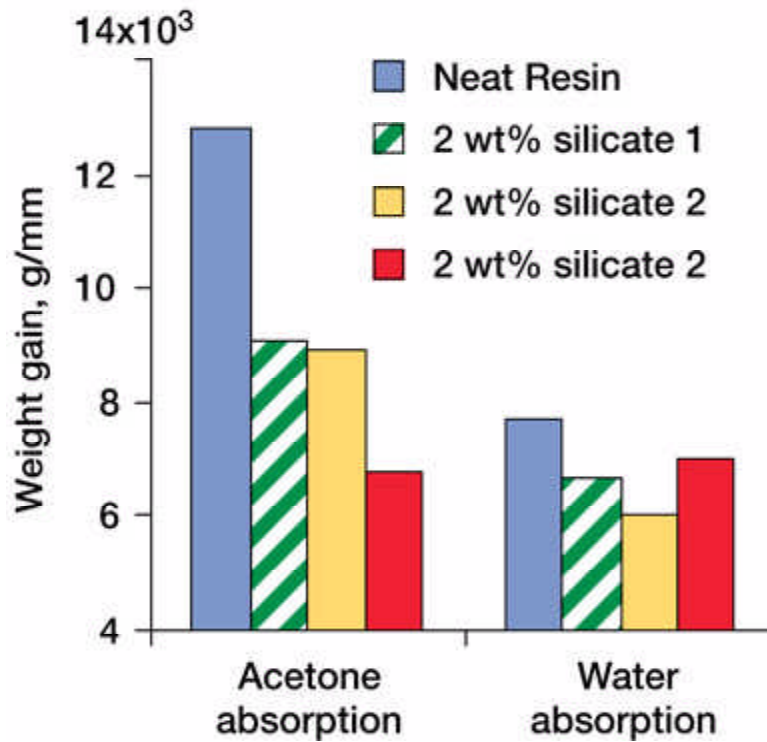
Polymer/Silicate Nanocomposites Developed for Improved Thermal Stability and Barrier Properties

The nanoscale reinforcement of polymers is becoming an attractive means of improving the properties and stability of polymers. Polymer-silicate nanocomposites are a relatively new class of materials with phase dimensions typically on the order of a few nanometers. Because of their nanometer-size features, nanocomposites possess unique properties typically not shared by more conventional composites. Polymer-layered silicate nanocomposites can attain a certain degree of stiffness, strength, and barrier properties with far less ceramic content than comparable glass- or mineral-reinforced polymers (ref. 1). Reinforcement of existing and new polyimides by this method offers an opportunity to greatly improve existing polymer properties without altering current synthetic or processing procedures.

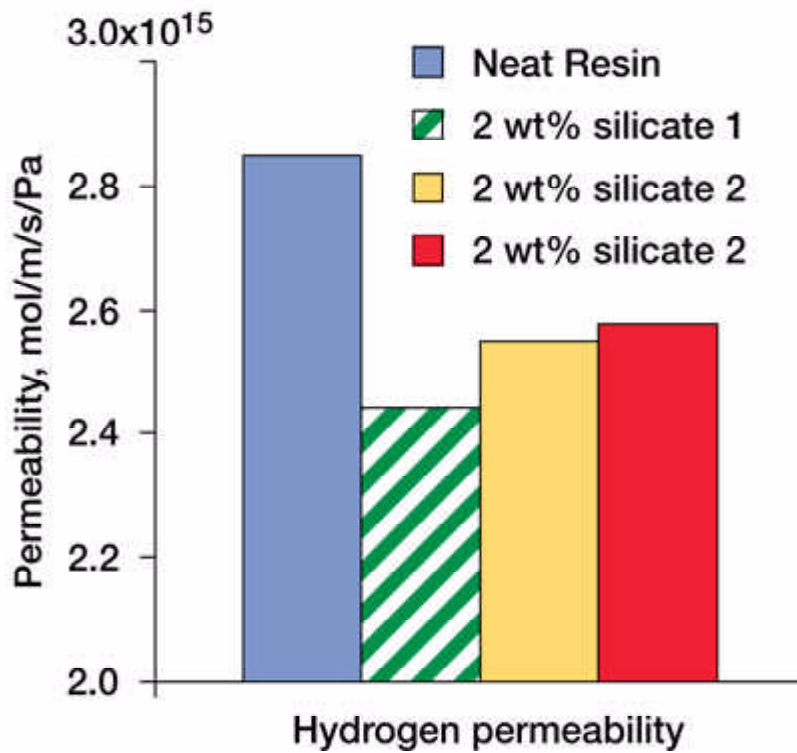


Comparison of the weight loss in carbon fabric composites with a neat PMR-15 matrix and a PMR-15/silicate matrix.

Highly crosslinked, thermally stable, thermosetting polymers have not been extensively researched as nanocomposite matrix materials. By dispersing a layered silicate into a PMR-15 matrix, there is the potential to increase the use temperature and the high-temperature performance of the polymer. Nanocomposite synthesis typically requires modification of the silicate interlayer with an organic material to improve the compatibility between the clay and the polymer. An understanding of the effects of the silicate on the melt viscosity and the crosslinking of the PMR-15 oligomers is important to the selection of a silicate-organic modification system that will optimize the benefits of the nanoscale reinforcement.



Acetone (28 hr) and water absorption (32 hr) into neat resin and polymer-silicate nanocomposites, where the structure of the ion exchange amine on the silicate varies in length and architecture.



Right: Hydrogen permeation (24 hr, 20 psi) through neat resin and polymer-silicate

nanocomposites, where the structure of the ion exchange amine on the silicate varies in length and architecture.

Recent efforts at the NASA Glenn Research Center have led to an organically modified silicate, which on dispersion in a PMR-15 matrix, leads to a nanocomposite with up to a 12-percent increase in thermal oxidative stability. Utilization of this PMR-15 nanocomposite as a matrix to a polymer carbon fabric (T650-35) composite increases the composite's thermal stability by 25 percent in comparison to a neat PMR-15 matrix composite.

An organically modified silicate was also dispersed in a thermoplastic polyimide matrix. The silicate was modified with protonated amines of varying lengths and architecture, and several nanocomposites were prepared. Water and acetone absorption into the neat resin and the nanocomposites were investigated. In comparison to that of the neat polymer, the absorption of acetone into the nanocomposite samples decreased 30 to 47 percent after 28 hr. In water, absorption decreased 10 to 22 percent after 32 hr. Hydrogen permeability testing of these materials resulted in a 10- to 20-percent decrease in permeability. The effectiveness of the nanocomposite in decreasing absorption or permeation depended on the silicate modification. The mechanical properties of both the thermosetting and thermoplastic polyimide matrix nanocomposites are currently being evaluated.

Find out more about this research

(<http://www.grc.nasa.gov/WWW/MDWeb/5150/Polymers.html>).

Bibliography

Burnside, S.D.; and Giannelis, E.P.: Synthesis and Properties of New Poly (Dimethylsiloxane) Nanocomposites. Chemistry of Materials, vol. 7, no. 9, 1995, pp. 1597-1600.

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